Efficiency of financial institutions

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Chapter 3

Institutions and Bank Performance[1]

A Stochastic Frontier Analysis

3.1 Introduction

For over a decade, academics have discussed the importance of institutional quality. Following e.g. Douglass North (1990), many economists have argued that institutions are the main determinants of welfare levels. Institutions "are the underlying determinant of the long-run performance of economies" (North, 1990). Acemoglu et al. (2004) argue that economic institutions determine the incentives of and the constraints on economic actors, and shape economic outcomes. They regard institutions as social decisions, chosen for their intended consequences. Because various groups and individuals typically benefit from different economic institutions, there usually will be a conflict over these social choices. Often the winners are the groups with greater political power. According to Acemoglu et al. (2004), the distribution of political power in society is determined by political institutions and the distribution of resources. Economic institutions encouraging economic growth emerge when political institutions allocate power to groups with interests in broad-based property rights enforcement, when they create effective constraints on power-holders, and when there are relatively few rents to be captured by power-holders.

Empirical support for the importance of well-developed institutions has been given by e.g. Knack and Keefer (1995), Rodrik et al. (2004), Acemoglu et al.

[1] This chapter is based on joint work with Robert Lensink.

(2001), Easterly and Levine (2003), and Kaufmann et al. (1999). In a growth accounting framework, institutional differences between countries play an important role in explaining differences in total factor productivity (TFP). Some countries have a lower TFP since the most productive technologies may not be appropriate and cannot be adopted due to institutional differences. A lower TFP can also be explained by inefficient use of technologies, due to rent seeking, corruption, monopoly power, or the immobility of factors of production (Jermanowski, 2006). Therefore, the institutional environment helps to determine the appropriate set of technologies in a country, and the degree to which the existing technology is efficiently used (Olson, 1982).

There is a growing literature that points to the importance of institutions for an efficient operation of the financial system. This literature argues that it is the economic, legal and social environment in which financial institutions and markets operate that is important for fostering economic growth (see La Porta et al. 1998, 2000). Proponents of the so-called legal view of financial development, for instance, argue that the distinction between a bank and a market-based financial system is irrelevant. It is more important to establish an institutional environment in which financial systems can operate efficiently. More generally, it is argued that only the part of financial development that is related to the institutional environment is important for fostering economic growth. The idea is that better institutions enhance competition throughout the economy. Numerous studies show that at the country level regulations and the quality of their enforcement affect (the protection of) investor rights. Several studies argue that proper functioning institutions allow financial markets and financial institutions to channel funds to ultimate investors in an efficient manner, which has a positive impact upon economic growth (see e.g. Beck and Levine, 2003, and Beck, Demirgüç-Kunt, and Levine, 2003). More generally, it is argued that better institutions positively affect bank efficiency (see also Demirgüç-Kunt, Laven, and Levine, 2004). Yet, the impact of institutions on bank efficiency is not undisputed. For instance, Japelli et al. (2005) show that better institutions have an ambiguous effect on bank efficiency. Better institutions positively affect bank efficiency by means of a decrease in cost of financial intermediation. However, better institutions may also improve access of low-grade

borrowers to the credit market, which raises the average rate of default, and hence may have a negative effect on bank efficiency. Indeed, more empirical research is needed to improve our understanding of the effect of institutions on bank efficiency.

Most studies use macro-economic data to find a relationship between institutions, financial development and economic growth. Levine (1998, 1999) and Levine et al. (2000), for instance, present a macro-economic empirical analysis in which they connect legal origin of countries to financial development and economic growth. They find that legal origin can be associated with cross-country differences in the development of the banking sector and stock markets. Beck et al. (2003) try to control for natural resources, religion and the differences in political systems in assessing the relationship between law and finance. Stulz and Williamson (2003) control for cultural differences in the countries when examining the impact of legal origin on financial development. Rajan and Zingales (2003) argue that political forces, especially materialized in laws that shape the financial sector and the business environment, play an important role too. Morck et al. (1998, 2000), Durnev et al. (2003, 2004) and Glaeser et al. (2004) focus on the impact of poor institutions on the equity market. They find that institutions like property rights, shareholder rights, stock market transparency and capital account openness contribute to efficient capital allocation and economic growth. Finally, Beck et al. (2006) find that a supervisory strategy that focuses on empowering private monitoring of banks by forcing banks to disclose accurate information to the private sector tends to lower the degree to which corruption of bank officials is an obstacle to firms raising external finance. They argue that regulations that empower private monitoring exert a beneficial effect on the integrity of bank lending in countries with sound legal institutions.

Several macroeconomic studies show the relevance of well-developed institutions for economic growth and financial development. Yet, these studies do not clarify how institutions influence individual banks. There are many studies examining the effect of institutions on financial development, but, surprisingly, there are almost no studies available that investigate the impact of institutions on bank efficiency. The only exception we are aware of is Demirgüç-Kunt, Laeven, and Levine (2004). They examine the impact of bank regulations, market structure,

and institutions on bank efficiency, and find some evidence for a positive effect of better institutions on bank efficiency. Our study complements their study by providing new empirical evidence on the relationship between institutions and bank efficiency. In contrast to the study by Demirgüç-Kunt, Laeven, and Levine (2004), who measure bank efficiency by net interest margins, we, for the first time ever, use a stochastic frontier analysis to determine the effects of institutions on bank efficiency. More in particular, since institutions may impact upon the inefficient use of technologies used by banks, as well as the appropriate technology that banks may adopt, our study seeks to evaluate the role of institutions both for adopting the appropriate technology and the efficiency of the technology in place. The analysis is based on an unbalanced set of more than 8,000 banks for 159 countries over 10 years. The stochastic frontier analysis allows estimating a best practice frontier for all banks, and the distance to the frontier for individual banks. We analyze whether differences in institutions may explain distances from this frontier for individual banks (i.e. to what extent play institutions a role in explaining inefficiency) and whether institutions can explain shifts in the frontier (i.e. to what extent institutions can explain the inability to adopt the most appropriate technologies). The results provide evidence for both possible effects of institutions on bank performance. Overall, the results underpin the importance of well-developed institutions for an efficient operation of commercial banks. The insights of the analysis confirm the importance of institutional reforms to improve bank efficiency.

The remainder of this chapter is scheduled as follows. Section 3.2 explains the methodology of the chapter. Section 3.3 describes the dataset and Section 3.4 presents the regression results. Finally, Section 3.5 provides a summary of this chapter.

3.2 The Methodology

We use a stochastic frontier analysis (SFA) model (see section 2.3) to analyze bank performance. SFA has been used by several authors to evaluate banking efficiency. For example, Berger and Mester (2001) for U.S. banking, Mendes and Rebelo (1999) for Portugese banking, Griffell-Tatje and Lovell (1996) and Kumbhakar et al. (2001) for Spanish banking, Berg et al. (1993) for Nordic banking, and

Kumbhakar and Sarkar (2003) for banking in India. Many efficiency studies focus on one country, although several studies also make cross-country comparisons (see e.g. Pastor et al., 1997).

In line with Berger and Mester (1997), we measure cost efficiency as how close a bank's cost is to what a best practice bank's cost would be for producing the same output bundle under the same conditions. We use stochastic frontier and more specifically, we use the Battese and Coelli (1995) SFA model, henceforth the BC model for reasons discussed in Section 2.3. In order to examine the effects of institutions on the financial system, we estimate a cost function and examine whether institutions affect this cost function. Moreover, we seek to evaluate to what extent the cost inefficiencies (the distance from the cost frontier) can be explained by differences in institutions. The cost function can be derived from a product function and input prices, see e.g. Sheppard (1970). The cost-function approach is the dual of the production function approach. We use the cost function approach since it is easier to estimate a model with multiple outputs using the cost function approach since the production function approach assumes a singe output in the context of the stochastic frontier analysis. Moreover, the cost function approach assumes that banks minimize costs, while the production-function approach assumes that banks maximize output. The cost function approach is more appropriate in a competitive environment where input prices are given and demand determines output.

The precise specification of the cost-function of a bank is debatable. Several models have been used in the literature (e.g. Benston, 1965 and Sealey and Lindley, 1977). We choose the model suggested by Sealey and Lindley (1977), who characterize a bank as an intermediary between those who have funds and those who are willing to borrow funds (see section 2.4). More specifically, we apply the transcendental logarithmic (translog) form as developed by Christensen, Jorgenson, and Lau (1973). This specification gives a better fit than the more common Cobb-Douglas form (Kumbhakar and Lovell, 2000).

The general BC model specifies a stochastic cost frontier with the following properties:

$$\ln C_{i,t} = C(y_{i,t}, w_{i,t}, q_t; \beta) + u_{i,t} + v_{i,t} \quad (3.1a)$$

Where $C_{i,t}$ is the total cost bank i faces at time t and $C(y_{i,t}, w_{i,t}; \beta)$ is the cost frontier. In this model bank efficiency is measured relative to a global best-practice frontier. This approach implicitly assumes that banks across different countries have equal access to the same banking technology. Alternatively, we could allow for different frontiers for each country in the sample. A drawback of the latter approach is that estimated efficiencies cannot be compared across countries. To control for the possibility that banks do not have equal access to the same technology in all countries, it is important to allow for cross-country differences in the frontier. As we will show below, we will control for cross-country differences by including proxies for the institutional environment, and by including country dummies.

Within the cost frontier, $y_{i,t}$ represents the logarithm of output of bank i at time t, $w_{i,t}$ is a vector of the logarithm of input prices of bank i at time t, q are country specific variables and β is a vector of all parameters to be estimated. The term $u_{i,t}$ captures cost inefficiency and has a truncated normal distribution.[2] $v_{i,t}$ captures measurement error and random effects, e.g. good and bad luck, and is distributed as a standard normal variable. Both $u_{i,t}$ and $v_{i,t}$ are time and bank specific.

The precise specification of the cost function we use is given by Eqation (3.1b). The dependent variable is *TC*, total costs. Outputs are given by the total customer loans (*TCL*) a bank issues and the amount of securities and other earning assets they hold (*TSOA*). The input prices we use are the price of funds (*PF*), defined as interest expenses over total deposits and total other funding, and price of labour (*PL*), defined by personnel expenses over total assets.[3] Year (*T*), year squared, and year interacted with output and input prices are included to detect trends.

[2] Thus, the total costs a bank faces are never lower than the costs of the frontier. For a graphical representation of the frontier and its dynamics see Berger et al. (1993). The authors show how inefficiency is determined by both technical and allocative inefficiency.

[3] Personnel expenses over total number of employees would be a better proxy, however, the number of employees is often not given in our dataset.

Finally, some additional bank characteristics are included. Loan loss reserves over gross loans (*LLR*) are included to control for risk taking by banks. In addition, other operating income over total assets (*OOIOTA*) proxies quality differences with regard to services of a bank.

$$\begin{aligned}\ln(TC) = {} & \beta_0 + \beta_1 \ln(TCL) + \beta_2 \ln(TSOA) + \beta_3 \ln(PL) + \beta_4 \ln(PF) \\ & + \beta_5 (\ln(TCL))^2 + \beta_6 (\ln(TSOA))^2 + \beta_7 (\ln(PL))^2 + \beta_8 (\ln(PF))^2 \\ & + \beta_9 \ln(TCL)\ln(TSOA) + \beta_{10} \ln(TCL)\ln(PL) + \beta_{11} \ln(TCL)\ln(PF) \\ & + \beta_{12} \ln(TSOA)\ln(PL) + \beta_{13} \ln(TSOA)\ln(PF) + \beta_{14} \ln(PL)\ln(PF) \\ & + \beta_{15} T + \beta_{16} T^2 + \beta_{17} \ln(TCL)T + \beta_{18} \ln(TSOA)T + \beta_{19} \ln(PL)T \\ & + \beta_{20} \ln(PF)T + \beta_{21} LLR + \beta_{22} OOIOTA + \beta_{23} Institutions + v_{i,t} + u_{i,t}\end{aligned} \tag{3.1b}$$

In order to test whether institutional differences impact upon efficiency, we include a proxy for institutions in the equation which explains inefficiency (Equation 3.2). The $m_{i,t}$ term in Equation (3.2) is the first moment of the truncated normal distribution of the $u_{i,t}$ term of Equation (3.1a) and (3.1b). Form more details about this distribution the reader is referred to Section 2.3. In this equation we included equity over total assets (*EQOTA*) to control for scale inefficiency effects. Furthermore we included return on average assets (*ROAA*) to control for management effects.

$$m_{i,t} = \delta_0 + \delta_1 EQOTA_{i,t} + \delta_2 ROAA_{i,t} + \delta_3 institutions_{i,t} \tag{3.2}$$

3.3 Data

We have an unbalanced dataset of 8,264 banks over 10 years (1996-2005) for 159 countries with in total 38,702 observations. Bank specific data come from the Bankscope database. We downloaded data for all commercial banks for which data are available. All variables are inflation adjusted. For descriptive statistics of the data we refer to Appendix A.

We use the set of aggregate governance indicators developed by Kaufmann et al. (2006) to proxy institutional differences. These indicators measure alternative

aspects of governance of a country. Although there are several other datasets that include institutional data, we choose for Kaufman since it includes most of those datasets and aggregate them into one dataset. The aggregate governance indicators from Kaufman et al. (2006) cover 215 countries and territories for 1996, 1998, 2000, 2002, 2003, 2004, and 2005 and are based on a broad range of individual variables measuring perceptions of governance, taken from 31 separate data sources. From 2002 onwards, yearly data are available. However, before 2002, the set of indicators is updated once in the two years only. For the missing years, we interpolated the data for the year before and after. Perceptions of governance include (i) the process by which governments are selected, monitored and replaced. (ii) the capacity of the government to effectively formulate and implement sound policies, and (iii) the respect of citizens and the state for the institutions that govern economic and social interactions among them.

Kaufmann et al. (2006) develop six indicators for the regulatory environment or 'governance' of a country. *GEF* (Government Effectiveness) is an indicator of the ability of the government to formulate and implement sound policies. *COR (*control of corruption) is an indicator that measures perceptions of corruption, interpreted as the exercise of public power for private gain. *LAW* (Rule of Law) is an indicator of the extent to which agents have confidence in and abide by the rules of society. Political instability and Violence (*PIV*) is an index that combines indicators of perceptions of the likelihood that the government in power will be destabilised or overthrown by possibly unconstitutional and/ or violent means. *REG* (Regulatory Quality) is an indicator of the ability of the government to formulate and implement sound policies. Finally, *VAC* (Voice and Accountability) is an index of indicators of the extent to which citizens of a country are able to participate in the selection of governments. These indicators are measured on a scale of about -2.5 to 2.5 with higher values corresponding to a 'better' regulatory environment. See Table 3.1 for precise definitions. Although, the Kaufmann et al. (2006) dataset is criticized (see e.g. Arndt and Oman, 2006; Knack, 2006; and Kurtz and Shrank, 2007) even critics cal it "probably the most carefully constructed governance indicators" (Arndt and Oman, 2006). General points of critique on the dataset are its uselessness for comparison of institutions over time or across

countries and its biases. These critiques, however, are all refuted (Kaufmann et al., 2007a; 2007b). Since the different indicators for institutional differences are highly correlated, we applied a principal component analysis and included one factor that explained more than 80 percent of the variance of all the 6 indicators.[4] We use this factor in our regressions.[5]

Institutions affect bank efficiency through various channels. Regarding the relevance of *voice and accountability*, we expect a higher level of media independence to increase the quality of information on local developments, which may reduce bank costs. Higher values of the *political stability and violence indicator* could lower banks' costs assuming that banks may run a risk of becoming a victim of violence. Moreover, loan loss provisions can decrease because of the lower risk. Better *government effectiveness* reduces costs of banks if banks are assumed to face difficulty in dealing with bureaucracy. Higher independence of the civil service from political pressure lowers banks' costs in those countries where political pressure against (entry of) banks is prevailing. Improvements in the *regulatory quality* help banks if it is accompanied by more adequate banking supervision. The quality of the *rule of law* affects cost efficiency through the

Table 3.1: Governance indicators defined
Source: Kaufman et al. (2006)

Institutional indicator	Definition
VAC: Voice and accountability	Measures the various aspects of the political process, civil liberties, political rights, and independence of the media.
PIV: Political stability and violence	Measure of perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional and/or violent means, including domestic violence and terrorism.
GEF: Government effectiveness	Responses on the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the governments commitment to policies.
REG: Regulatory quality	Measures of incidence of market-unfriendly policies such as price controls or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.
LAW: Rule of law	Measures the extent to which agents have confidence in and abide by the rules of society. These include perceptions of the incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts.
COP: Control of corruption	Measures the exercise of public power for private gain, including both petty and grand corruption and state capture.

[4] Details on the principle component analysis can be found in Appendix A Table A-6.
[5] We also included the 6 variables separately in our regressions and the results did not qualitatively differ.

effectiveness and predictability of the judiciary. When going to court is time consuming, bank costs will increase. Finally, enhanced *control of corruption* influences cost efficiency by lowering the costs of bribing. Overall, we hypothesize that better institutions, i.e. higher values of the six governance indicators, lower a bank's cost inefficiency. We also hypothesize that better institutions may shift the cost function inside, implying that better institutions allow banks to adapt more productive technologies.

3.4 Estimation results

We present three sets of estimates. In the first set we test whether institutions affect efficiency. In the second set we examine whether institutions affect the cost frontier. In the last set of estimates we allow institutions to affect both the cost frontier and efficiency. The idea of including a particular variable both in the frontier and in the efficiency specification is not new (e.g. e.g. Battese and Broca; 1997, Lundvall and Battese; 2000, and Bos et al.; 2009). These models are identified due to the specific distributional assumptions that have been made. The estimation results are given in Tables 3.2, 3.3 and 3.4, respectively. For each set we show five types of models. Model 1 and 2 have the specification given in Equation (3.1b). For model 3 and 4 we excluded the two variables that control for specific bank characteristics, since the inclusion of these control variables drastically reduces the number of observations. Furthermore, we decided to include country dummies to control for other country characteristics besides institutions. These estimates are given in model 2 and 4 for each set. In model 5 the country dummies are included in the efficiency term, and not in the frontier.

We start by considering the impact of institutions on efficiency. These estimates are presented in Table 3.2. The table shows that input prices and outputs as well as their squared counterparts are, except for $ln(PF)^2$, positive and significant at the usual significance levels. This is in line with expectations as an increase in input prices or in outputs increases costs. The table also shows that, in general, the impact of the included trend variables is not stable. In addition, total customer loans turn out to have a negative impact on total cost over time. Our proxy for risk, *LLR* is positive and highly significant, indicating that banks that are faced

with more risk have extra costs. The proxy that measures the differences in quality of services, *OOIOTA,* is positive and significant at the one percent level. This suggests that banks that offer more services face higher costs. Most importantly, institutional variables in the inefficiency term are always negative and highly significant. This indicates that banks are more efficient if the institutional environment is better. We test the impact of efficiency with a likelihood ratio test. A description of the test and its significance is given in Appendix B. Appendix B also explains the interpretation of sigma squared and gamma. For all models, it appears that the impact of efficiency is high.

Next we turn to the impact of institutions on the frontier. These estimates are presented in Table 3.3. The impact of the control variables is qualitatively the same as in Table 3.2. More importantly, in all specifications institutions have a negative sign and are statistically significant. This provides evidence for the hypothesis that well-developed institutions may lower bank costs, and that banks are better able to adopt new technologies in a healthy institutional environment.

Finally, we present estimates for which we allow institutions to both affect the frontier and the efficiency term. These regressions are presented in Table 3.4. The results for the cost function variables, as well as the bank specific variables are still qualitatively the same. Most interestingly, institutions seem to simultaneously affect the cost function and improve efficiency.

Table 3.2: Institutions in the inefficiency term

Model	[1]	[2]	[3]	[4]	[5]
Frontier			Panel A		
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Dependent Variable					
Ln(*TC*)					
Intercept	1.687***	Country	1.816***	Country	1.552***
	[0.118]	Effects	[0.062]	Effects	[0.064]
Ln(TCL)	0.564***	0.621***	0.504***	0.524***	0.493***
	[0.017]	[0.017]	[0.010]	[0.010]	[0.010]
Ln(TSOA)	0.268***	0.285***	0.414***	0.422***	0.440***
	[0.016]	[0.016]	[0.009]	[0.010]	[0.010]
Ln(PL)	1.224***	0.929***	1.403***	1.133***	1.286***
	[0.042]	[0.042]	[0.023]	[0.023]	[0.024]
Ln(PF)	0.055***	0.113***	0.039***	0.081***	0.040**
	[0.021]	[0.021]	[0.014]	[0.015]	[0.015]
$Ln(TCL)^2$	0.076***	0.071***	0.084***	0.080***	0.082***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(TSOA)^2$	0.061***	0.059***	0.073***	0.070***	0.072***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(PL)^2$	0.044***	0.016***	0.062***	0.031***	0.046***
	[0.004]	[0.004]	[0.002]	[0.003]	[0.003]
$Ln(PF)^2$	0.003**	-0.006***	0.006***	-0.002	-0.001
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]
Ln(TCL)ln(TSOA)	-0.125***	-0.123***	-0.148***	-0.145***	-0.146***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(TCL)ln(PL)	0.013***	0.013***	-0.006***	-0.003	-0.007***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
Ln(TCL)ln(PF)	-0.010***	-0.015***	-0.008***	-0.005***	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PL)	-0.019***	-0.017***	0.006***	0.001	0.006***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PF)	0.003	0.006***	-0.001	-0.005***	-0.010***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Ln(PL)ln(PF)	0	0.004	-0.003	-0.001	-0.010***
	[0.005]	[0.005]	[0.003]	[0.003]	[0.003]
T	0.006	0.009	0.042***	0.039***	0.034***
	[0.011]	[0.010]	[0.006]	[0.005]	[0.006]
T^2	0.002***	0.001*	-0.000*	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln(TCL)T	-0.006***	-0.004***	-0.005***	-0.003***	-0.003***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(TSOA)T	0.002*	0.003***	0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(PL)T	0.002	0.005***	0.002**	0.003***	0.001
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(PF)T	0.004***	0.001	0.004***	0.002**	0.005***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
LLR	0.007***	0.005***			
	[0.000]	[0.000]			
OOIOTA	3.173***	3.730***			
	[0.130]	[0.130]			

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. TC stands for total costs. The outputs are total customer loans (TCL) and total securities and other earning assets (TSOA) while the input prices are price of labor (PL) and price of funds (PF). T denotes a time trend. Loan loss reserves over gross loans (LLR) is a proxy for risk taking while other operating income over total assets (OOIOTA) measures differences in services.

Table 3.2: Institutions in the inefficiency term (Continued)

Model	[1]	[2]	[3]	[4]	[5]
			Panel B		
Efficiency					
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Constant	0.082*	-1.124***	-0.736***	-4.246***	Country
	[0.042]	[0.173]	[0.087]	[0.575]	Effects
EQ/TA	0.005***	0.015***	0.019***	0.043***	0.009***
	[0.001]	[0.002]	[0.001]	[0.005]	[0.001]
ROAA	-0.068***	-0.120***	-0.086***	-0.186***	-0.068***
	[0.003]	[0.007]	[0.004]	[0.014]	[0.002]
Institutions	-0.192***	-0.192***	-0.419***	-0.705***	-0.071**
	[0.009]	[0.019]	[0.020]	[0.076]	[0.029]
$sigma^2$	0.298	0.546	0.589	1.464	0.301
gamma	0.881	0.947	0.958	0.985	0.924

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. EQ/TA stands for equity over total assets and ROAA stands for return on average assets. The variable *institutions* is our measure for institutional quality. It is obtained by applying principal component analysis on the six Kaufmann indicators. $Sigma^2$ denotes the total amount of variance in the model. Gamma gives the ratio of variance of the inefficiency term over the total amount of variance.

Additional robustness check

The analysis so far strongly suggests that a healthy institutional environment provides abilities for banks to adapt new technologies, and to use existing technologies more efficiently. Yet, our estimation strategy may be criticized since institutions slowly change over relatively long periods, which may imply that it is difficult to identify the impact of institutions on banks in a panel framework. Although we did not encounter identification problems, we present an additional set of estimates in Table 3.5. For this set of estimates, we suppressed time-series variance by performing a SFA on the means of all banks in the sample. By taking the unit means, all changing variables are treated as time-invariant, which improves identification. This analysis complements the regressions presented so far. Again we find that a better institutional environment enhances efficiency of banks, and enables banks to adopt better technologies. Overall, our analysis thus strongly supports the view that the institutional environment is extremely important for the behavior of banks.

Table 3.3: Institutions in the frontier

Model	[1]	[2]	[3]	[4]	[5]
			Panel A		
Frontier					
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Dependent Variable					
Ln(*TC*)					
Intercept	1.819***	Country	1.953***	Country	1.571***
	[0.116]	Effects	[0.066]	Effects	[0.065]
Ln(TCL)	0.565***	0.618***	0.536***	0.535***	0.496***
	[0.018]	[0.017]	[0.010]	[0.010]	[0.010]
Ln(TSOA)	0.267***	0.286***	0.381***	0.408***	0.437***
	[0.017]	[0.016]	[0.010]	[0.010]	[0.010]
Ln(PL)	1.205***	0.892***	1.390***	1.086***	1.282***
	[0.041]	[0.041]	[0.023]	[0.024]	[0.024]
Ln(PF)	0.040*	0.109***	0.044***	0.077***	0.038**
	[0.022]	[0.021]	[0.015]	[0.015]	[0.015]
$Ln(TCL)^2$	0.076***	0.070***	0.082***	0.079***	0.081***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(TSOA)^2$	0.061***	0.058***	0.072***	0.069***	0.072***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(PL)^2$	0.044***	0.013***	0.062***	0.026***	0.045***
	[0.004]	[0.004]	[0.002]	[0.003]	[0.003]
$Ln(PF)^2$	0.001	-0.005**	0.005***	-0.001	-0.002*
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]
Ln(TCL)ln(TSOA)	-0.125***	-0.122***	-0.145***	-0.143***	-0.146***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(TCL)ln(PL)	0.015***	0.013***	-0.001	-0.001	-0.007***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
Ln(TCL)ln(PF)	-0.004*	-0.014***	-0.005***	-0.004**	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PL)	-0.022***	-0.016***	0.001	-0.001	0.005***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PF)	0	0.005**	-0.004**	-0.006***	-0.010***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Ln(PL)ln(PF)	-0.002	0.004	-0.005*	-0.003	-0.011***
	[0.005]	[0.005]	[0.003]	[0.003]	[0.003]
T	0.006	0.001	0.032***	0.029***	0.033***
	[0.011]	[0.010]	[0.006]	[0.006]	[0.006]
T^2	0.001***	0.001	-0.000*	-0.001***	-0.001***
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
Ln(TCL)T	-0.004***	-0.003***	-0.004***	-0.002***	-0.003***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(TSOA)T	0.001	0.002**	0.001	0	-0.001*
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(PL)T	0.003	0.004**	0.001	0.001	0
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(PF)T	0.002**	0.001	0.004***	0.002*	0.005***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
LLR	0.006***	0.006***			
	[0.000]	[0.000]			
OOIOTA	3.253***	3.755***			
	[0.138]	[0.132]			
Institutions	-0.056***	-0.059***	-0.049***	-0.063***	-0.007***
	[0.002]	[0.010]	[0.001]	[0.007]	[0.002]

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. TC stands for total costs. The outputs are total customer loans (TCL) and total securities and other earning assets (TSOA) while the input prices are price of labor (PL) and price of funds (PF). T denotes a time trend. Loan loss reserves over gross loans (LLR) is a proxy for risk taking while other operating income over total assets (OOIOTA) measures differences in services. The variable *institutions* is our measure for institutional quality. It is obtained by applying principal component analysis on the six Kaufmann indicators.

Table 3.3: Institutions in the frontier (Continued)

Model	[1]	[2]	[3]	[4]	[5]
			Panel B		
Efficiency					
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Constant	-1.294***	-1.945***	-7.119***	-8.512***	Country
	[0.189]	[0.255]	[0.913]	[1.044]	Effects
EQ/TA	0.017***	0.023***	0.077***	0.079***	0.010***
	[0.002]	[0.003]	[0.008]	[0.008]	[0.001]
ROAA	-0.118***	-0.146***	-0.231***	-0.285***	-0.072***
	[0.007]	[0.009]	[0.020]	[0.024]	[0.003]
$sigma^2$	0.518	0.624	1.800	1.958	0.314
gamma	0.916	0.949	0.984	0.988	0.927

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. EQ/TA stands for equity over total assets and ROAA stands for return on average assets. $Sigma^2$ denotes the total amount of variance in the model. Gamma gives the ratio of variance of the inefficiency term over the total amount of variance.

Table 3.4: Institutions in the frontier and inefficiency term

Model	[1]	[2]	[3]	[4]	[5]
Frontier			Panel A		
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Dependent Variable					
Ln(*TC*)					
Intercept	1.744***	Country	1.838***	Country	1.574***
	[0.117]	Effects	[0.063]	Effects	[0.065]
Ln(TCL)	0.570***	0.622***	0.506***	0.525***	0.496***
	[0.017]	[0.017]	[0.010]	[0.010]	[0.010]
Ln(TSOA)	0.261***	0.283***	0.411***	0.420***	0.437***
	[0.017]	[0.016]	[0.010]	[0.010]	[0.010]
Ln(PL)	1.216***	0.924***	1.402***	1.130***	1.284***
	[0.041]	[0.042]	[0.023]	[0.023]	[0.024]
Ln(PF)	0.053**	0.115***	0.037***	0.081***	0.038**
	[0.021]	[0.021]	[0.014]	[0.015]	[0.015]
$Ln(TCL)^2$	0.076***	0.071***	0.084***	0.080***	0.081***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(TSOA)^2$	0.061***	0.059***	0.073***	0.070***	0.072***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Ln(PL)^2$	0.043***	0.016***	0.062***	0.031***	0.045***
	[0.004]	[0.004]	[0.002]	[0.003]	[0.003]
$Ln(PF)^2$	0.001	-0.006***	0.005***	-0.002	-0.002*
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]
Ln(TCL)ln(TSOA)	-0.125***	-0.122***	-0.148***	-0.145***	-0.146***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(TCL)ln(PL)	0.014***	0.013***	-0.005***	-0.003	-0.007***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
Ln(TCL)ln(PF)	-0.009***	-0.015***	-0.007***	-0.005***	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PL)	-0.021***	-0.017***	0.005***	0.001	0.005***
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
ln(TSOA)ln(PF)	0.003	0.006***	-0.001	-0.005***	-0.010***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Ln(PL)ln(PF)	0	0.005	-0.003	-0.001	-0.011***
	[0.005]	[0.005]	[0.003]	[0.003]	[0.003]
T	0.008	0.006	0.041***	0.038***	0.033***
	[0.011]	[0.010]	[0.006]	[0.005]	[0.006]
T^2	0.002***	0.001**	-0.000*	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln(TCL)T	-0.005***	-0.004***	-0.005***	-0.003***	-0.003***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(TSOA)T	0.002	0.003***	0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Ln(PL)T	0.003	0.004**	0.002**	0.003***	0
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Ln(PF)T	0.003**	0.001	0.004***	0.002**	0.004***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
LLR	0.006***	0.005***			
	[0.000]	[0.000]			
OOIOTA	3.175***	3.719***			
	[0.133]	[0.130]			
Institutions	-0.022***	-0.031***	-0.006***	-0.027***	-0.007***
	[0.003]	[0.011]	[0.002]	[0.008]	[0.002]

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. TC stands for total costs. The outputs are total customer loans (TCL) and total securities and other earning assets (TSOA) while the input prices are price of labor (PL) and price of funds (PF). T denotes a time trend. Loan loss reserves over gross loans (LLR) is a proxy for risk taking while other operating income over total assets (OOIOTA) measures differences in services. The variable *institutions* is our measure for institutional quality. It is obtained by applying principal component analysis on the six Kaufmann indicators.

Table 3.4: Institutions in the frontier and inefficiency term (Continued)

Model	[1]	[2]	[3]	[4]	[5]
			Panel B		
Efficiency					
Nr. of Observations	15,939	15,939	38,702	38,702	38,702
Constant	-0.277***	-1.188***	-0.953***	-4.436***	Country
	[0.092]	[0.183]	[0.132]	[0.609]	Effects
EQ/TA	0.008***	0.015***	0.021***	0.044***	0.009***
	[0.001]	[0.002]	[0.002]	[0.005]	[0.001]
ROAA	-0.083***	-0.122***	-0.092***	-0.189***	-0.071***
	[0.004]	[0.007]	[0.005]	[0.015]	[0.003]
Institutions	-0.188***	-0.188***	-0.439***	-0.715***	-0.061**
	[0.012]	[0.019]	[0.024]	[0.079]	[0.031]
$sigma^2$	0.381	0.558	0.649	1.511	0.313
gamma	0.902	0.948	0.962	0.985	0.926

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. EQ/TA stands for equity over total assets and ROAA stands for return on average assets. The variable *institutions* is our measure for institutional quality. It is obtained by applying principal component analysis on the six Kaufmann indicators. $Sigma^2$ denotes the total amount of variance in the model. Gamma gives the ratio of variance of the inefficiency term over the total amount of variance.

Table 3.5: Estimates on unit means

Model	[1]	[2]	[3]	[4]	[5]	[6]
				Panel A		
Frontier						
Nr. of Observations	8,264	8,264	8,264	3,836	3,836	3,836
Dependent Variable						
Ln(*TC*)						
Intercept	1.893***	1.942***	1.949***	1.475***	1.559***	1.540***
	[0.105]	[0.109]	[0.105]	[0.176]	[0.173]	[0.173]
Ln(TCL)	0.473***	0.514***	0.483***	0.541***	0.566***	0.560***
	[0.018]	[0.019]	[0.018]	[0.030]	[0.031]	[0.030]
Ln(TSOA)	0.466***	0.411***	0.450***	0.283***	0.269***	0.268***
	[0.017]	[0.018]	[0.018]	[0.029]	[0.030]	[0.029]
Ln(PL)	1.404***	1.327***	1.388***	1.103***	1.073***	1.095***
	[0.042]	[0.043]	[0.041]	[0.069]	[0.068]	[0.068]
Ln(PF)	0.033	0.031	0.025	0.121***	0.087**	0.110***
	[0.026]	[0.027]	[0.026]	[0.038]	[0.039]	[0.039]
$Ln(TCL)^2$	0.082***	0.081***	0.082***	0.078***	0.078***	0.078***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
$Ln(TSOA)^2$	0.075***	0.075***	0.075***	0.065***	0.065***	0.065***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
$Ln(PL)^2$	0.063***	0.056***	0.061***	0.035***	0.033***	0.034***
	[0.005]	[0.005]	[0.005]	[0.007]	[0.007]	[0.007]
$Ln(PF)^2$	0.005***	0.002	0.003	-0.004	-0.007**	-0.006**
	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]
Ln(TCL)ln(TSOA)	-0.151***	-0.149***	-0.151***	-0.131***	-0.133***	-0.132***
	[0.002]	[0.002]	[0.002]	[0.003]	[0.004]	[0.003]
Ln(TCL)ln(PL)	-0.014***	-0.008**	-0.013***	0.012**	0.016***	0.014**
	[0.003]	[0.003]	[0.003]	[0.006]	[0.006]	[0.006]
Ln(TCL)ln(PF)	-0.003	-0.001	-0.002	-0.012***	-0.006	-0.011**
	[0.003]	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]
ln(TSOA)ln(PL)	0.017***	0.009***	0.015***	-0.015***	-0.019***	-0.018***
	[0.003]	[0.003]	[0.003]	[0.006]	[0.006]	[0.006]
ln(TSOA)ln(PF)	-0.001	-0.002	-0.001	0.008*	0.005	0.008*
	[0.003]	[0.003]	[0.003]	[0.005]	[0.005]	[0.005]
Ln(PL)ln(PF)	0	-0.002	-0.002	0.012	0.008	0.011
	[0.006]	[0.006]	[0.006]	[0.008]	[0.009]	[0.009]
LLR				0.004***	0.005***	0.004***
				[0.001]	[0.001]	[0.001]
OOIOTA				3.376***	3.801***	3.524***
				[0.268]	[0.302]	[0.290]
Institutions		-0.064***	-0.022***		-0.061***	-0.027***
		[0.002]	[0.004]		[0.003]	[0.006]

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. TC stands for total costs. The outputs are total customer loans (TCL) and total securities and other earning assets (TSOA) while the input prices are price of labor (PL) and price of funds (PF). Loan loss reserves over gross loans (LLR) is a proxy for risk taking while other operating income over total assets (OOIOTA) measures differences in services.

Table 3.5: Estimates on Unit Means (Continued)

	[1]	[2]	[3]	[4]	[5]	[6]
			Panel B			
Efficiency						
Constant	-0.151*	-6.821***	-0.797***	0.151**	-1.989***	-0.382
	[0.081]	[1.872]	[0.238]	[0.064]	[0.616]	[0.234]
EQ/TA	0.012***	0.074***	0.017***	0.005***	0.028***	0.010***
	[0.002]	[0.016]	[0.003]	[0.001]	[0.006]	[0.003]
ROAA	-0.082***	-0.291***	-0.109***	-0.064***	-0.150***	-0.090***
	[0.006]	[0.059]	[0.012]	[0.006]	[0.025]	[0.013]
Institutions	-0.326***		-0.382***	-0.182***		-0.193***
	[0.022]		[0.041]	[0.016]		[0.028]
sigma2	0.384	1.662	0.556	0.226	0.550	0.336
gamma	0.945	0.984	0.960	0.852	0.915	0.888

* significant at 10%; ** significant at 5%; *** significant at 1% and standard errors in brackets. TC stands for total costs. The outputs are total customer loans (TCL) and total securities and other earning assets (TSOA) while the input prices are price of labor (PL) and price of funds (PF). Loan loss reserves over gross loans (LLR) is a proxy for risk taking while other operating income over total assets (OOIOTA) measures differences in services. The variable *institutions* is our measure for institutional quality. It is obtained by applying principal component analysis on the six Kaufmann indicators. EQ/TA stands for equity over total assets and ROAA stands for return on average assets. Sigma^2 denotes the total amount of variance in the model. Gamma gives the ratio of variance of the inefficiency term over the total amount of variance.

3.5 Conclusion

This chapter examines whether institutional differences between countries improve the efficient operation of commercial banks. We test whether well developed instuitions affect the adoption of the technology used by banks, and the efficient use of the technology in place. By applying a stochastic frontier analysis on a panel of more than 8,000 banks for 159 countries over 10 years we show that banks operating in countries with better institutions apply more cost reducing technologies, and are able to use the technologies in place more efficiently. Overall, the results underpin the importance of well-developed institutions for an efficient operation of commercial banks. The insights of the analysis confirm the scope for institutional reforms to improve bank efficiency.